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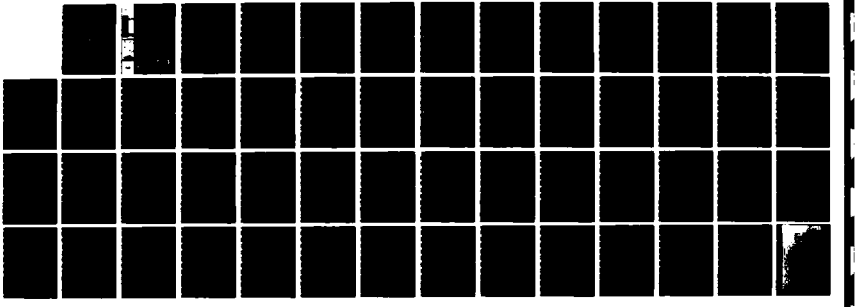

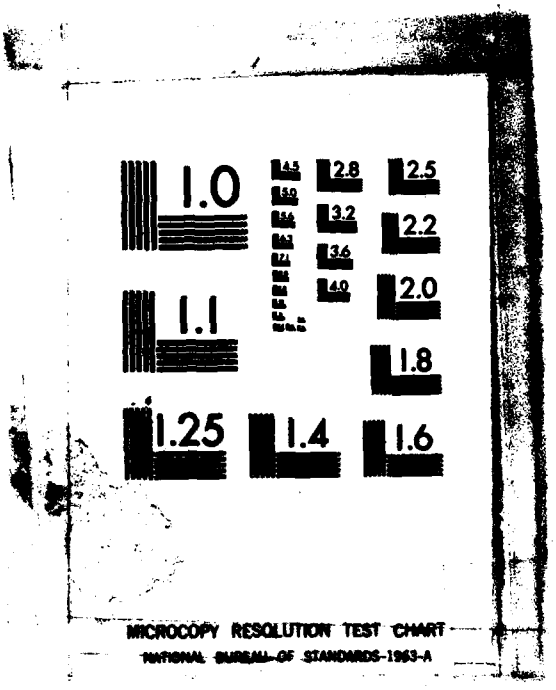
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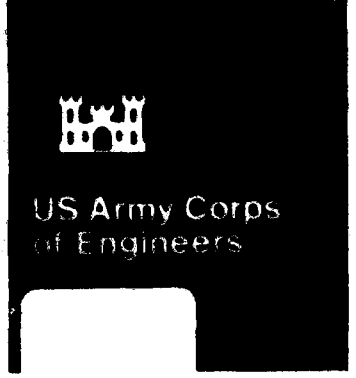

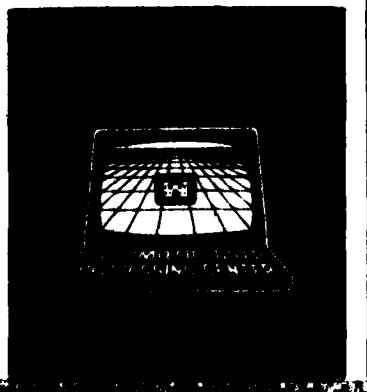

INSTRUCTION REPORT K-84-3

12

USER'S GUIDE: MODIFIED SLOPE STABILITY PACKAGE WITH KANSAS CITY ANALYSIS (DGSLOPE)

by

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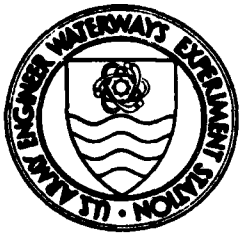

January 1984
Final Report

Prepared for Office, Chief of Engineers, U. S. Army
Washington, D. C. 20314

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Critical pool	Kansas City format	WESLIB format
DGSLOPE	Partial pool	
Drawdown	Slope stability program	
Drum plots	Soil profile	

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report is a user's guide for DSGLOPE, a package of slope stability analysis programs with interactive graphics and drum plot capabilities. Five existing slope stability programs form the DGSLOPE package. Three of these came from the U. S. Army Engineer Waterways Experiment Station (WES) computer program library, WESLIB. The two additional slope stability programs came from the U. S. Army Kansas City District Office. Two of these programs (SSA003 (WES) and KCARC (KC) utilize the circular arc method of analysis: the other three (SSW028(WES), SSW39A (WES) and KCWED (KC)) employ the wedge method.

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PREFACE

This report provides instructions for using DGSLOPE, an interactive computer graphics slope stability package with drum plot capabilities. An existing series of slope stability programs (SSA003, SSW028, and SSW39A) was combined to form the original DGSLOPE. The Kansas City series of slope stability programs has recently been added to DGSLOPE. This latest work is a joint effort between the U. S. Army Engineer Waterways Experiment Station (WES) and the U. S. Army Engineer Division, Lower Mississippi Valley (LMVD) computer center for fiscal year 1983. Part of this work was initiated and funded during fiscal year 1980 by the Computation and Analysis Branch Office, Chief of Engineers (OCE).

The programs SSA003, SSW039A and SSW028 were developed by Mr. James B. Cheek, formerly of the WES Automatic Data Processing (ADP) Center. The analytical procedures have been reported by Mr. Cheek in WES Miscellaneous Papers K-73-2, K-76-3, and K-77-1.

The original DGSLOPE was primarily constructed by Mr. Robert L. Hall, ADP Center. Ms. Janet Jackson, ADP Center, assisted in coding and testing the original code. Mr. James Jones, ADP Center, provided axis routines that were used for the drum plot. Mr. Michael Pace did considerable work in testing the original program and has recently completed the major part of adding the Kansas City package to DGSLOPE.

The Kansas City slope stability package was developed by Mr. Richard Davidson, then of the Kansas City District. The package was documented in the Kansas City District publication, "Program Writeup for Slope Stability Analysis". The revised report was published in January 1976.

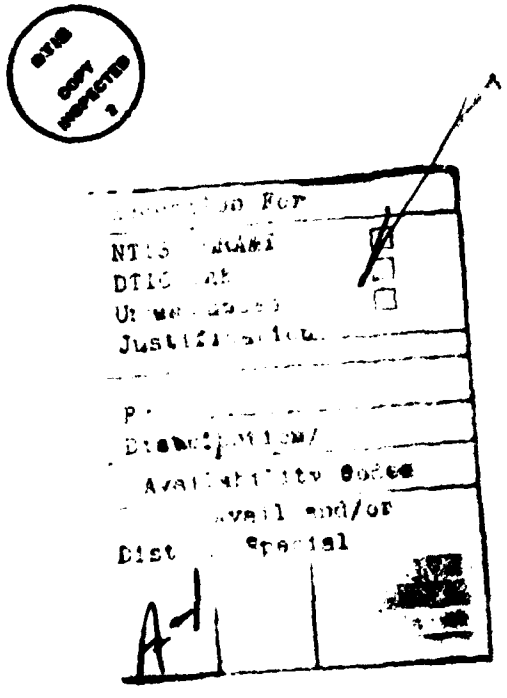
The original user's guide was prepared by Mr. Hall and Mr. Paul K. Senter, ADP Center, using major parts of the command description as reported earlier by Mr. Cheek.

This user's guide was prepared by Mr. Pace and Mr. Hall and includes much of the original user's guide.

The U. S. Army Engineer District, Vicksburg, provided technical guidance for the work on the package. Liaison was maintained between the District and WES by means of telephone conversations and office visits with Messrs. Larry A. Cooley and Eugene G. Wardlaw, Foundation and Materials Branch. Mr. Tony Young,

Geology, Soils and Materials Branch, was the LMVD point of contact. Dr. N. Radhakrishnan was technical coordinator of the work.

Commander and Director of WES during the preparation and publication of this report was COL Tilford C. Creel, CE. Technical Director was Mr. Fred R. Brown.



CONTENTS

CONVERSION FACTORS, U. S. CUSTOMARY (NON-SI) TO METRIC (SI) UNITS OF MEASUREMENT

U. S. Customary (SI) units of measurement used in this report can be converted to metric (SI) units as follows:

Multiply	By	To Obtain
feet	0.3048	meters
inches	2.54	centimeters
pounds (force) per square foot	47.88026	pascals
pounds (mass)	0.45359237	kilograms
pounds (mass) per cubic foot	16.01846	kilograms per cubic meter

USER'S GUIDE: MODIFIED SLOPE STABILITY PACKAGE WITH KANSAS CITY ANALYSIS (DGSLOPE)

PART I: INTRODUCTION

Purpose

1. This report is a user's guide for DGSLOPE, a package of slope stability analysis programs with interactive graphics and drum plot capabilities. The package consists of five slope stability analysis programs. Three existing slope stability programs in the U. S. Army Engineer Waterways Experiment Station (WES) computer program library, WESLIB, and two Kansas City programs were combined to form the DGSLOPE package. The first of the three WESLIB programs (SSA003*) utilizes the circular arc method of analysis; the other two (SSW028** and SSW39A†) employ two different wedge methods of analysis. One of the Kansas City programs uses a wedge method, while the other uses the circular arc method of analysis††, both of which perform an automatic search for a minimum safety factor.

Scope

Input Features

2. The DGSLOPE package is easy to work with because it allows the user to interact with the program in a conversational manner. It does not force the user to follow a sometimes inefficient data preparation procedure; rather, it allows him to dictate the program action using a series of simple commands.

---

* Cheek, J. B. 1973. "Instruction Manual for Using WES Time-Sharing System for Analysis of Slope Stability (The Circular Arc Method)", Miscellaneous Paper K-73-2, U. S. Army Engineer Waterways Experiment Station, Vicksburg, Miss.

** _____. 1976. "Instruction Manual for Using Time-Sharing System for Analysis of Slope Stability; Wedge Method", Miscellaneous Paper K-76-3, U. S. Army Engineer Waterways Experiment Station, Vicksburg, Miss.

† _____. 1977. "Analysis of Slope Stability, Wedge Method Using Head Profiles to Model Uplift Pressures", Miscellaneous Paper K-77-1, U. S. Army Engineer Waterways Experiment Station, Vicksburg, Miss.

†† Davidson, R. F. 1976. "Program for Slope Stability Analysis", U. S. Army Corps of Engineers, Kansas City District, Kansas City, Mo.

3. The program assists the user in preparing input data in two ways: (1) by displaying the input graphically as it is being defined, thereby allowing visual monitoring of information that has been input and (2) by prompting the user with data preparation instructions printed at the terminal following each command. To speed the input process on the time-sharing system, the user can input data from a previously prepared data file.

4. DGSLOPE checks the input data and prints error messages if the data violate program requirements. Since this feature does not guarantee the accuracy of the data, the program has commands which allow the user to change much of the input.

Output

5. DGSLOPE provides plots from a graphics storage tube terminal and a drum plotter. For the three WESLIB programs previously mentioned, a plot of the water profile, soil profile, and failure surface may be obtained after each stability analysis is complete. Upon completion of all analyses, the user can obtain a drum plot displaying the soil profile and failure surface for any or all of the individual analyses. The drum plot capability applies to all the programs in the package.

PART II: OPERATING PROCEDURE

Overview

6. Although each facet of the operating procedure will subsequently be covered in detail, the following overview of the procedure describes how the facets interact.

7. Seated at the Tektronix 4014 terminal or its equivalent, the user calls the computer, identifies himself, and requests a run of DGSLOPE. The program asks for the name of a restart file (this file will be used to save the data used as input for the last stability calculations). The program then requests a data title, which the user supplies (this title will be stored in the first line of the restart file for identification purposes). The program then asks for a command which the user supplies. Through this and subsequent commands, the program does any or all of the following: receives or alters soil properties, soil profiles, pool elevation, and neutral block base points; modifies the computational procedure; and evaluates stability for the data stored. DGSLOPE also displays soil profiles, pool elevation, piezometric head points, neutral blocks, arcs, and the phreatic profile. After investigating several failure surfaces, the user may find it necessary to sign off and attend to other duties, even though he has not completed his analysis. He may do so without fear of losing his data because all the data items used in the last analysis are stored by the program in the restart file. They are ready for use when he next has an opportunity to work on the problem.

Input Preparation

Time-Sharing Mode

8. The following sequence of commands will start DGSLOPE time-sharing execution on the Honeywell DPS-1 (user responses are underlined):

SYSTEM: FORT N

READY

*RUN WESLIB/DGSLOPE,R

9. The program now has control of the terminal and after a pause (whose length depends on the number and type of other time-sharing problems) will type:

SLOPE STABILITY ANALYSIS PACKAGE WITH DRUM PLOTS

SUPPLY NAME OF RESTART FILE

=

The user then types in the desired file name and a carriage return. The program stores the file name and erases all data in that file. Therefore the user either must give a new (previously unused) file name or be sure that the data stored under any old file name that he may reuse are no longer needed.

10. After this file is established, the program types

SUPPLY TITLE FOR THIS RUN

=

The user supplies a title for this run that may contain up to 60 characters (blanks count as characters). This title will be written on the first line of the restart file (Note that all data files must have a title on the first line). By choosing data and restart file names in a systematic manner, such as making the first character a number, the user will be able to easily locate all data files and identify them by their title. This capability is most useful when many jobs and their associated files are being processed. Consequently, the user must be sure to give accurate, meaningful titles to his runs.

11. After the title is saved, the program types:

ENTER COMMAND (LEVEL 1)

=

The user may now begin to use commands to enter, display, and/or run stability analyses. "Level 1" indicates that the program is expecting input commands for entering data. The "Level 2" commands are used for control when producing drum plots of the output. If the user enters an invalid command, the program will give the user an option to view a list of valid commands. If the user elects to view the list, the program will be set for the full conversational mode of interaction. Note the following example:

```
ENTER COMMAND (LEVEL 1)
= XXXXX
COMMAND UNKNOWN
DO YOU WISH A LIST OF VALID COMMANDS ? ENTER (Y OR N)
=Y
ARC DATA
```

```
SOIL DATA
PROGRAM CONTROL
NEUTRAL BLOCK
EDIT XXXX
POOL ELEVATIONS
PHREATIC PROFILE
PIEZOMETRIC HEAD
INSERT SOIL
GENERATE ARCS
RUN XXXX
CONVERSATIONAL OUTPUT
NO CONVERSATIONAL OUTPUT
TABLE OF SOIL PROPERTIES
READ OLD DATA FILE
WINDOW PROFILE
DISPLAY PROFILE
GAMMA (UNIT WEIGHT OF WATER, PCF)
PERCENT CONSOLIDATION
SLOPE OF ACTIVE EARTH FORCES
SS (SOIL STRENGTH CODE)
RS (RESTART)
DELETE XXXX
STOP

ENTER COMMAND (LEVEL 1)
=
```

12. At this point, most users will be able to close this guide and follow the instructions given by the program at the terminal. However, the rest of this user's guide describes what can be expected from each command and the restrictions and limitations on the program and data. A list of all commands with brief explanation is given in Appendix A to aid in running DGSLOPE.

Optional Output

13. The user can call up detailed data preparation instructions with each data input command code by using the full conversational mode. The output of the full conversational mode for each command is shown in the following text in capital letters. The optional output giving the detailed instructions is underlined and is available only under the full conversational mode. The restricted conversational mode will print only the non-underlined text.

Soil Profile Data

Soil Input Command = SO

14. This command is used for all five programs to enter the coordinates and soil properties of each individual soil profile.

15. The program responds to command SO with:

SOIL 1 PROPERTIES

SATURATED	Q TEST	R TEST	S TEST
UNIT WT.,	PHI, COHESION,	PHI, COHESION,	PHI, COHESION

- OR -

SAT. WT.	MOIST WT.	Q TEST(1 TO 3)	R TEST	S TEST
		PHI, COHESION,	PHI, COHESION,	PHI, COHESION

-

16. The first set of data refers to the WESLIB programs, while the second set refers to the Kansas City programs. For the Kansas City programs, the saturated unit weight is used below the water table, and the moist unit weight is used above the water table. Up to 3 sets of strength parameters may be entered for the Q test.

17. The user should type in the saturated unit weight and moist unit weight, if applicable, in pounds per cubic foot; the Q, R, and S test values for the friction angle (PHI), in degrees; and cohesion (C), in pounds per square foot. A carriage return is then entered to save the material properties data.

18. If the user wishes to switch back and forth between the various programs, i.e., from the WESLIB programs to the Kansas City and vice versa, then the data should be input in the Kansas City format. The Kansas City programs require data additional to that required for the WESLIB programs. Thus, entering data in the Kansas City format will satisfy all the programs.

19. The program stores the properties and requests:

SOIL PROFILE

X(1), Y(1), X(2), Y(2), ..., X(N), Y(N)

-

The user supplies these points (distance and elevation, in feet) on the exterior profile in ascending order by distance (X). Note that this exterior profile must extend beyond the surface intersection points of any wedges on acres to be studied.

20. Should more than one line of data be required for the profile, the

last point on the line should be followed by a comma and then a carriage return. The program will store this portion of the profile. When the program is ready for the remainder of the data, it will type an equal sign on the next line. The user must wait for the equal sign before supplying additional points.

21. The SO command is used repetitively to input the properties and profile data for the interior soils. The program numbers each new soil in steps of one, starting with 1 for the first soil. Soils must be defined working from high elevations to low, because each profile erases all portions of profiles below it. Any valid portion of a profile erased by this procedure must be redefined with an additional lower soil.

22. The Kansas City program requires the soil profile to extend the entire length of the section. This procedure for defining the soil profile will be accepted by the WESLIB program. However, if only the WESLIB programs are used, profiles may begin and/or end interior to the section.

23. The screen is erased, and all data are displayed after each soil profile is defined. Following is the input for the first soil profiles.

```
ENTER COMMAND (LEVEL 1)
*SO

SOIL 1 PROPERTIES

SATURATED     Q TEST          R TEST          S TEST
UNIT WT.,  PHI, COHESION,  PHI, COHESION,  PHI, COHESION

- OR -

SAT. WT.  MOIST WT.  Q TEST(1 TO 3)      R TEST          S TEST
                     PHI, COHESION,  PHI, COHESION,  PHI, COHESION
*125 115 30 0 30 0 30 0

SOIL PROFILE

X(1), Y(1), X(2), Y(2), ... X(N), Y(N)
*-300 400 -250 400 -10 480 110 480
```

The first profile is displayed in Figure 1.

```
ENTER COMMAND (LEVEL 1)
*
```

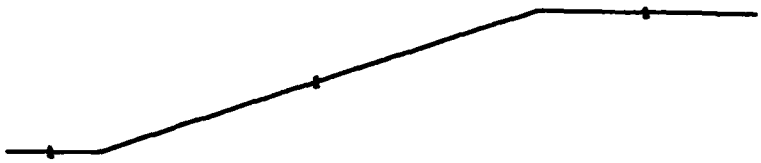


Figure 1. Display of soil 1 data using SO command

The input for the second profile follows.

```
ENTER COMMAND (LEVEL 1)
*SO

SOIL 2 PROPERTIES

SATURATED     Q TEST          R TEST          S TEST
UNIT WT.,  PHI, COHESION,  PHI, COHESION,  PHI, COHESION

- OR -

SAT. WT.  MOIST WT.  Q TEST(1 TO 3)      R TEST          S TEST
                     PHI, COHESION,  PHI, COHESION,  PHI, COHESION
*150 145 45 1000 30 2000 30 2500 45 5000 45 5000

SOIL PROFILE

X(1), Y(1), X(2), Y(2), ... X(N), Y(N)
*-300 400 110 400
```

The display for both profiles is shown in Figure 2.

```
ENTER COMMAND (LEVEL 1)
*
```

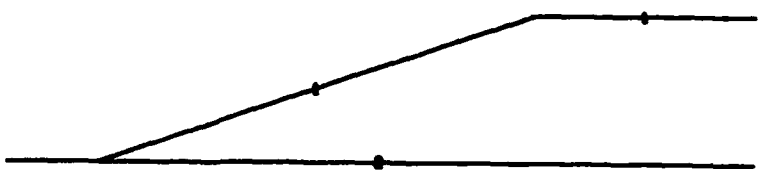


Figure 2. Display of soil 1 and 2 data using SO command

The soil profiles are displayed using the same scale factor in both the X and Y directions. The scale factor is chosen to use as much of the screen as possible. If a soil profile point is improperly input, the X and Y coordinates of the point can be changed using the EDIT SOIL (ED SO) command. The soil properties can be changed using the EDIT MATERIAL (ED MA) command.

Failure Surface Data

24. The following commands are used to enter failure surface data. A total of 25 failure surfaces may be entered for use in any one of the WESLIB programs. Only one failure surface may be entered at a time for use in the Kansas City programs. Only one initial failure surface is needed for the Kansas City programs because additional failure surfaces are generated in search of a minimum safety factor.

25. Either the WESLIB format or the Kansas City format may be used to enter data. If data are entered in the Kansas City format, the WESLIB programs may also be run on the same data. For example, if the soil and arc data are entered in the Kansas City format, the user may also run the WESLIB arc program without re-entering the data in the WESLIB format.

26. Both arc and wedge data may exist together. Either both sets of data, arc and wedge, may be entered in the same format, or the arc data may be entered in one format and the wedge data in another.

27. Data for a particular analysis will be erased each time the user changes the format of data entry. For example, if a user enters 5 neutral blocks in the WESLIB format and then enters another neutral block in the Kansas City format, the data entered in the WESLIB format will be replaced by the data entered in the Kansas City format. In this case, after the fifth neutral block has been entered, the program will request the sixth neutral block. When the user enters the sixth neutral block in the Kansas City format, the program will erase all previous neutral blocks and store the present neutral block as neutral block number one.

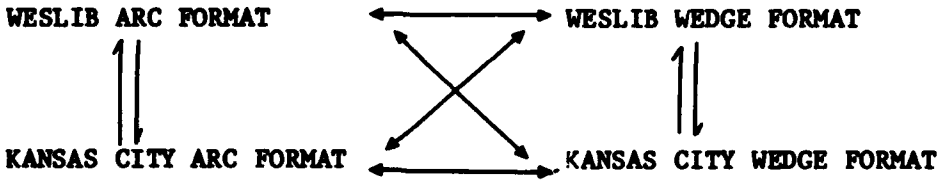
28. In the Kansas City format, the current failure surface can be replaced by simply typing in a new failure surface, as long as the new surface is entered in the Kansas City format.

29. All of the previous options discussed are summarized below:

 - indicates that the current data stored by a particular

format will be replaced by data entered in another format. Both formats must be for the same type of analysis, either arc or wedge.

 - indicates that data entered for the arc and wedge analyses are stored for use.



Neutral Block Command = NE

30. The NE command is used to input the coordinates of the end points of the neutral block base used in the wedge method analysis. The program responds to the NE command with:

NEUTRAL BLOCK BASE NUMBER N

LEFT	RIGHT	COMPUTATION
X, Y,	X, Y,	CONTROL

-OR-

ACTIVE	PASSIVE	COMPUTATION	ACT.	PASS.	VERT.
X, Y,	X, Y,	CONTROL	INC.	INC.	INC.

=

where N is the neutral block number assigned by the program.

31. The WESLIB wedge programs may store up to 25 neutral blocks for subsequent analysis by repeating the NE command, while the Kansas City wedge program may store only one neutral block. If desired, other data may be modified and used with the same neutral block data. After each neutral block is defined, it is displayed with the soil profile as shown in Figure 3

```
ENTER COMMAND (LEVEL 1)
*NE

NEUTRAL BLOCK BASE NUMBER   1

 LEFT   RIGHT   COMPUTATION
 X,  Y, X,  Y,  CONTROL

 - OR -

 ACTIVE  PASSIVE  COMPUTATION  ACT.  PASS.  VERT.
 X,   Y, X,    Y, CONTROL      INC.  INC.   INC.
*0 400 -150 400 1 5 5 0


ENTER COMMAND (LEVEL 1)
*
```

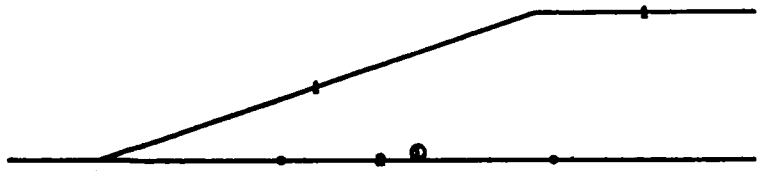


Figure 3. Input and display resulting from NE command

32. The coordinates of the neutral block are supplied in feet. The WESLIB programs should be given the left and right coordinates of the neutral block. The Kansas City wedge program must be given the coordinates of the active and passive sides of the neutral block. A computation control number is required which specifies the computations to be made according to the following code:

Computations Control No.	Program Action
1	Evaluates safety factors for after construction, sudden drawdown, partial pool, and critical pool (The embankment is saturated below the before drawdown pool elevation for the sudden drawdown case.)
0	Same as for number 1 except that the phreatic surface defined by command PH (paragraph 47) data is used in the drawdown computations (The elevation of the lower horizontal pool defined by the phreatic profile must be the same as the after drawdown pool elevation.)
-1	Evaluates safety factors for after construction and steady seepage R and S strengths (The phreatic profile used for seepage computations is defined by data input by the command PH; the lower elevation of the phreatic profile must be the same as the tailwater elevation.)
-2	Same as -1 except that the phreatic profile is horizontal at the headwater elevation out to the shell, coincident with the shell down to the tailwater elevation and horizontal at the tailwater elevation

The computation control flag is used only in the WESLIB wedge programs but is included in the input list for the Kansas City wedge program to allow the user to run both programs from the same input data.

33. For the Kansas City wedge program, increments for the active and passive side of the neutral block plus a vertical increment for the neutral block are required. If zeros are input for any of the increments, no search will be made in that direction. If a vertical increment is used and the failure plane is inclined within the neutral block, the elevations of the neutral block are adjusted so that the slope of the failure plane remains constant.

ARC Input Command = AR

34. The program responds to the AR command with:

```
ARC 1
ARC CENTER AT          ARC       COMPUTATON
DISTANCE, ELEVATION,   RADIUS,   CONTROL FLAG, XINC, YINC, RINC, RMAX
=
```

35. The WESLIB arc program may store up to 25 arcs for subsequent analysis by repeating the AR command, while the Kansas City arc program may store only one arc for analysis. The same arc data may be used repeatedly while other data are modified. After each arc is input it is displayed as seen in Figure 4.

```
ENTER COMMAND (LEVEL 1)
*AR

ARC  1

    ARC CENTER AT      ARC       COMPUTATION
DISTANCE, ELEVATION,  RADIUS,  CONTROL FLAG, XINC, YINC, RINC, RMAX
*-30 500 90 1 5 5 5 0

ENTER COMMAND (LEVEL 1)
*
```

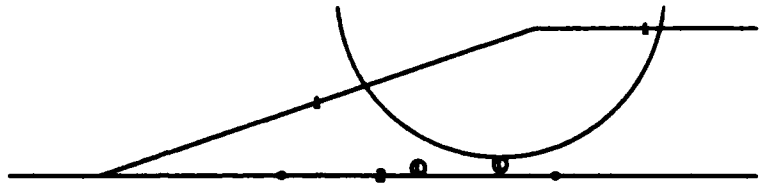


Figure 4. Input and display resulting from AR command

Arcs which do not intersect the embankment surface and those having intersections higher than the arc center (overhanging failure surface) will produce error messages.

36. The user supplies the distance and elevation of the arc center (in feet), the arc radius (in feet), and the computation control flag for both the WESLIB and Kansas City arc programs. For the Kansas City arc program, increments must be supplied for the coordinate of the arc center and the arc radius. If a zero is input for any of these increments, searching in that direction will not occur. A maximum value of the radius that will be used in the search procedure is also needed. If a zero is input, no limit will be placed on the radius.

37. A computation control flag must be input which selects the computation to be made for the arc being entered. The computations are specified by the following code:

Computation Control Flag	Program Action
1	Evaluates safety factors for effectiveness after construction, sudden drawdown, partial pool, and critical pool (The embankment is saturated below the before drawdown pool elevation for the sudden drawdown case.)
0	Same as for number 1 except that the phreatic surface defined by phreatic profile data is used in the drawdown computations (The elevation of the lower horizontal pool defined by the phreatic profile must be the same as the after drawdown pool elevation.)
-1	Evaluates safety factors for after construction and steady seepage R and S strengths (The phreatic profile used for seepage computations is defined by command PH (paragraph 47); the lower elevation of the phreatic profile must be the same as the tailwater elevation.)
-2	Same as -1 except that the phreatic profile is horizontal at the headwater elevation out to the shell, coincident with the shell down to the tailwater elevation, and horizontal at the tailwater elevation

Although the computation control flag is used only in the WESLIB arc program, it is included in the data list for the Kansas City arc program to allow the user to run both the Kansas City and WESLIB programs from the same input data.

Arc Generating Command = GE

38. This command applies only to the WESLIB arc program. The Kansas City arc program generates its own arcs using the values given for the arc increments described under the AR command (paragraph 34).

39. The arc generating routine produces a family of arcs that are all tangent to a horizontal plane and pass through a common point. The program has two modes of operation, selected by the KASE value. KASE is a variable used to select the stability analysis case to be used. The operating modes and computations set by each KASE value are discussed in the following paragraphs.

40. Arc generating mode. The generating mode calculates slope stability for a series of arcs, starting with radius RS (see paragraph 42, page 19), and increasing the radius of successive arcs by DEL until radius RF is used. All arcs in the group are tangent to a plane at elevation EL and pass through the point XP, YP. (The above criteria were chosen to aid in investigating a circular failure surface that passes through a point on or within the embankment and is coincident with a relatively weak horizontal stratum.) Program operation is unchanged except that arcs are produced automatically, and KASE takes on the function of the computation control flag.

41. Arc searching mode. The searching mode differs from the generating mode in several respects.

a. The program stops the arc generating process when the safety factor computed for the current arc is greater than the safety factor computed for the previous arc of the group. The effect of this feature is to halt the generating process when a minimum safety factor has been found, based on the assumption that arcs having longer radii will produce larger safety factors.

b. Only one stability analysis case is computed.

c. The variable KASE is used to select the stability analysis case to be used. Only values 2 through 6 may be used for this searching mode.

d. The previously established delete options are erased (The delete options must be reset via command PR (paragraph 63) before the program is used in any other computation mode).

Program action for each KASE value is as follows:

KASE	Program Action
-2	Computes after construction, steady seepage R strength, and steady seepage S strength cases; Assumed saturated-to-shell conditions below the headwater elevation for seepage computations
-1	Same as -2 except that the tailwater elevation and phreatic profile data are used in seepage computations
0	Computes after construction, sudden drawdown, and partial pool cases and locates the critical pool elevation (The after drawdown pool elevation and phreatic profile data are used in the sudden drawdown computations.)
1	Same as 0 except that saturated-to-shell conditions are assumed below the before drawdown pool elevation for the sudden drawdown computations
2	Computes only after construction case
3	Computes only sudden drawdown case
4	Computes only partial pool case
5	Computes only steady seepage R strength case
6	Computes only steady seepage S strength case

Note that the KASE numbers 2 through 6 have the reverse effect of the same delete options (paragraph 65); that is, they allow only the prescribed computation rather than delete one and allow all others.

42. The program responds to command GE with:

ARC GENERATING PARAMETERS

KASE, XP, YP, EL, RS, DEL, RF, DIR

=

The functions of the eight arc generating parameters are presented below.

Parameter Name	Used For
KASE	Computation control
XP, YP	The distance and elevation coordinates, respectively, of the common point
EL	The elevation of the horizontal plane
RS	The radius of the initial arc (The arc center must be above the highest point on the failure surface; that is, RS must be greater than (YP - EL).)
DEL	The difference in the radius of successive arcs
RF	The maximum generated arc length
DIR	Indicates whether arc centers are on the left (DIR = -1) or right right (DIR = 1) of the common point

43. Changes in program and data. Two major changes take place when the arc generator is used.

a. All arc data previously stored are not used.

b. Only the strength selector and print control delete options (numbers 1 and 8) will remain unchanged.

After the arc generated parameters have been input, the first arc is displayed as seen in Figure 5.

```
ENTER COMMAND (LEVEL 1)
*GE

ARC GENERATING PARAMETERS

KASE, XP, YP, EL, RS, DEL, RF, DIR
*5 -225 450 410 100 5 120 1

ENTER COMMAND (LEVEL 1)
*
```

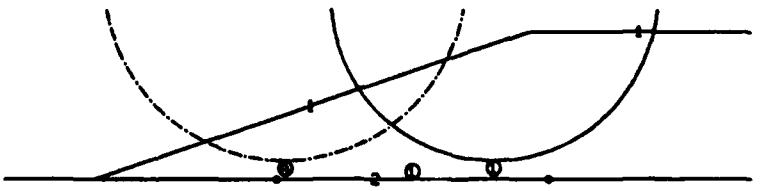


Figure 5. Input and display resulting from GE command

Water Surface Data

44. The following commands are used to establish hydrostatic loading

conditions. All of the commands apply to the WESLIB programs, while only the PH command is used in conjunction with the Kansas City programs.

Pool Input Command = PO

45. The program responds to this command with:

POOL EL.

GROUNDWATER FOR CONSTRUCTION CASE,	PARTIAL POOL,	BEFORE DRAWDOWN,	AFTER DRAWDOWN,	SEEPAGE HEADWATER,	SEEPAGE TAILWATER

=

The user replies with elevations for the pools. Pools elevations must reference the same elevation datum as other coordinate data (soil profile, phreatic profile, and arc center). The program supplies an initial value of zero for the the pool elevations. This zero value will be used in all computations if the pool command is not given.

46. The function of each pool elevation in the computation procedure is listed below.

a. The groundwater elevation is used in the after construction computations. The program uses saturated unit weight with Q shear strength data above this elevation and submerged unit weight with Q shear strength data below this elevation. Delete option 1 causes R strength data to be used below this elevation and Q strength data above.

b. The partial pool elevation is used during upstream analysis (wedge computation control value of 1 or 0). The safety factor is computed for the partial pool at this elevation using R shear strength data. The program uses saturated unit weight above the pool and submerged unit weight below. This feature allows the user to study pool elevations that are independent of those chosen by the automatic critical pool location procedure.

c. The before drawdown elevation is used during upstream analysis as the upper elevation for sudden drawdown saturated-to-shell computations (wedge or arc computation control value of 1). This value is ignored when the sudden drawdown phreatic surface is defined by phreatic profile data.

d. The after drawdown elevation specifies the elevation of the pool after sudden drawdown has taken place. This value is used during the upstream analysis of sudden drawdown computations (wedge or arc computation control values of 0 and 1). This value must agree with the lowest elevation of the phreatic profile data when those data are used to define the sudden drawdown phreatic surface (wedge or arc computation control value of 0).

e. The headwater elevation is used during downstream analysis as the upper pool elevation for saturated-to-shell steady seepage computations (wedge for arc computation control value of -1). This value is ignored when the seepage phreatic surface is

defined by phreatic profile data (wedge computation control value of -2).

f. The tailwater elevation specifies the lower pool elevation used in downstream analysis of steady seepage (wedge or arc computation control values of -1 and -2). This value must agree with the lowest elevation of the phreatic profile data when they are used to define the steady seepage phreatic surface profiles (wedge or arc computation value of -1).

The pool elevations are displayed after all pools have been input, as shown in Figure 6.

```
ENTER COMMAND (LEVEL 1)
*PO

POOL EL.

GROUND WATER FOR   PARTIAL BEFORE    AFTER     SEEPAGE    SEEPAGE
CONSTRUCTION CASE, POOL,   DRAWDOWN, DRAWDOWN, HEADWATER, TAILWATER
*400 430 470 450 470 450

ENTER COMMAND (LEVEL 1)
*
```

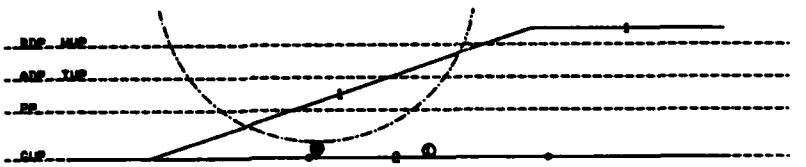


Figure 6. Input and display resulting from PO command

Phreatic Profile Input Command = PH

47. The program responds to this command with:

```
PHREATIC profile points
X(1), Y(1), X(2), Y(2), ... X(N), Y(N)
=
```

The user replies with the distance (X) and elevation (Y) coordinates, in feet, of the points that describe the profile of either the sudden drawdown or steady seepage phreatic surface.

48. The phreatic profile points must be in ascending numerical order by distance. It is unlikely that one profile can be used to define both seepage and drawdown conditions, although the program will attempt to use whatever phreatic profile data are stored in the analysis of either or both conditions. The best practice is to define either the seepage or drawdown profile phreatic surface, making all calculations required, and then define the other phreatic surface and complete the remaining calculations. Figure 7 shows the input and display of the phreatic profile data. Phreatic surface data are used for all

analyses except for the WESLIB wedge program which uses the piezometric head data to calculate uplift along the failure surface. However, not all of the programs interpret the phreatic surface in the same manner. Both Kansas City analysis programs interpret the phreatic surface data in the same manner by requiring the phreatic surface to be described the entire length of the outer soil profile. If a level pool is used, only one point needs to be defined. The WESLIB-ARC program also requires the profile to be defined the length of the outer profile. The phreatic data must also follow the guidelines (paragraph 45) for defining pool elevations. The WESLIB wedge program only requires the phreatic profile to be defined on the interior of the outer shell. The pool elevations are used to calculate the location where the pool elevations intersect the outer shell. These intersection points and pool elevations described in paragraphs 45-46 are used to describe the phreatic surface exterior to the outer soil profile.

```
ENTER COMMAND (LEVEL 1)
*PH

PHREATIC PROFILE POINTS

X(1), Y(1), X(2), Y(2), ... X(N), Y(N)
*-75 450 -50 460 0 465 50 470

ENTER COMMAND (LEVEL 1)
*
```

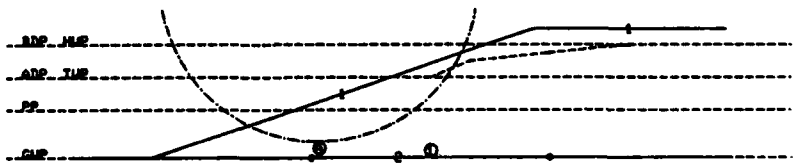


Figure 7. Display resulting from PH command

Piezometric Head Profile Command = PI

49. The program responds to this command with:

```
PIEZOMETRIC HEAD PROFILE
X(1), Y(1), H(1), X(2), Y(2), H(2), ... X(N), Y(N), H(N)
=
```

The user supplies the head data profile points consisting of the distance and elevation of each point and the piezometric head, in feet, at that point. As previously noted, the points on each head data profile must be recorded in ascending order of distance.

50. Should more than one line of data be required for the head of any profile, the last head value on the line should be followed by a comma and then

a carriage return. The program will store this portion of the profile data. When it is ready for additional data, the program will type an equals sign on the next line. Be sure to wait for the equals sign before supplying additional data. Note that the first profile must define the phreatic surface (head values must be zero). Each additional profile is supplied by giving command PI followed by the data for that profile. Figure 8 shows the display of the piezometric head profile data.

```
ENTER COMMAND (LEVEL 1)
*
```

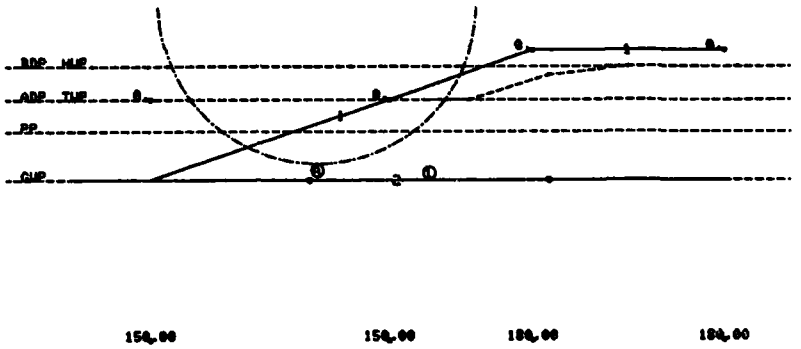


Figure 8. Display resulting from PI command

PART III: KANSAS CITY PROGRAM COMMANDS

51. The following commands are for use with the Kansas City arc and wedge programs. These commands may be used repeatedly to vary certain parameters while using the same soil, water, and failure surface data.

Unit Weight of Water Command = GA

52. The default value for the unit weight of water used in the program is 62.4 pounds per cubic foot (pcf*). This command may be used to alter the value of the unit weight of water. The program responds to the GA command with:

```
ENTER UNIT WEIGHT OF WATER (PCF).
=
```

The unit weight of water should be input in pcf.

Slope of Active Earth Forces Command = SL

53. Information about the failure surface used in the analysis is input with this command. The program responds to the SL command with:

```
SLOPE DATA
SLOPE OF ACTIVE EARTH FORCES    WIDTH OF SLICES    DELTA THETA (DEG)    MAX. NUMBER OF TRIAL WEDGES
-OR-
SLOPE OF ACTIVE EARTH FORCES    WIDTH OF SLICES    MAX. NUMBER OF TRIAL ARCS
=
```

54. The user should enter the slope of the earth forces between the active wedge and central block as a positive number. The width of the slices used to divide up the wedges should be entered in feet. The increment (Delta Theta) by which the angle of the active and passive wedge failure planes are varied should be entered in degrees. If a zero is entered for the maximum number of trials, 90 is assumed.

55. If the slope data are input in the format for the wedge data, the arc data are also satisfied.

---

* A table of factors for converting U. S. customary (NON-SI) units of measurement to metric (SI) units is presented on page 5.

Soil Strength Code Command = SS

56. The program responds to the SS command with:

```
SOIL STRENGTH CODE
ENTER 1,2,3,4,5 FOR Q,R,S,S&R,OR S&(S+R)/2
=
```

A code should be selected which corresponds to one of the following:

Strength code	Failure envelope used
1	Use Q-strength (or partial consolidation)
2	Use R-strength
3	Use S-Strength
4	Use S and R composite envelope
5	Use S and (R+S)/2 intermediate envelope

Percent Consolidation Command = PE

57. If the soil strength code described under command SS is chosen to be 1, the percent consolidation for each soil layer may be entered. The program responds to the command PE with:

```
CONSOLIDATION DATA
ENTER THE PERCENT CONSOLIDATION FOR EACH SOIL IN ORDER
=
```

The percent consolidation is entered as a percentage with no decimal point.

PART IV: OPTIONAL COMMANDS

58. The following commands affect either the program output, data display, or data input. All of the optional commands apply to both the WESLIB and Kansas City programs, except the PR command, which applies only to the WESLIB programs.

Conversational Mode Command = CO

59. The full conversational mode is an optional feature which does not become effective until an invalid command or the CO command is given. The CO command causes the program to provide additional input instructions for the data input command codes.

Delete Conversational Mode Command = NO

60. This command deletes the conversational text associated with the command CO. As mentioned previously, the teletype output controlled by command CO is underlined in this report.

Read Data from an Old File Command = RE

61. This command causes the program to request the following:

SUPPLY THE NAME OF THE INPUT DATA FILE
=

The user must supply the name (4 to 8 characters) of the file that contains the input data and then a carriage return. After the file name is stored, the program will change from the restricted conversational (experienced user) mode to the unattended mode of operation. It will read the successive lines of data in the input file.

62. When all the data have been read, the program will return to the restricted conversational mode and request the next command from the terminal. At this point, the user may change or process the data presently in storage or read and process data from another file. A simple example using this mode follows:

```
ENTER COMMAND (LEVEL 1)
*RE
SUPPLY NAME OF INPUT DATA FILE
*DGSL
```

The display of data in the file, DGSL, are shown in Figure 9.

```
ENTER COMMAND (LEVEL 1)
*
```

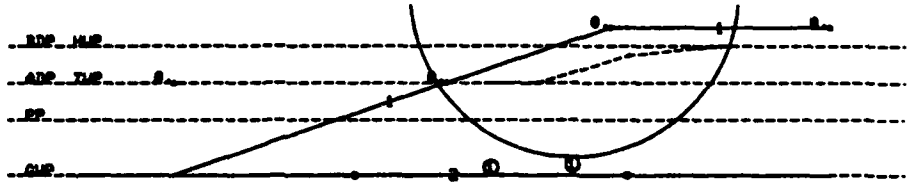


Figure 9. Display resulting from RE command

Program Control Command = PR

63. This command is used only when one or more of the following standard values or option is unacceptable (items a and b apply only to the arc program):

a. Earthquake acceleration is 0.05 g's.

b. Number of slices is 20.

c. Computations for positive computation control flag are: after construction, sudden drawdown, partial pool, and critical pool.

d. Computations for negative computation control flag are: after construction, steady seepage R strengths, and steady seepage S strengths.

e. After construction analysis uses Q strengths at the failure surface of each slice, without regard to the groundwater.

f. Program output includes the tabulation of failure surface coordinates, weight, and head of water at each segment of the failure surface.

g. Program output includes a tabulation of the input data.

64. The program responds to command PR with:

PROGRAM CONTROL

EARTHQUAKE G LOAD, NUMBER OF SLICES, LIST THE NUMBER OF EACH DELETE OPTION DESIRED

=

The user supplies the earthquake horizontal acceleration in units of gravity, the number of slices (the maximum is 30) required for compatibility with the arc method program, and the number for each delete option required for subsequent computations. All previously established delete options are removed.

65. The program action for each delete option is shown below for all programs in this series:

Number	Program Action
1	Uses R instead of Q strength below the groundwater elevation for after construction case
2	Deletes computation of after construction case
3	Deletes computation of sudden drawdown case
4	Deletes computation of partial and critical pool cases
5	Deletes computation of steady seepage R strength case
6	Deletes computation of steady seepage S strength case
7	Deltes computation of critical pool location
8	Deletes failure surface coordinate printing
9	Deletes plotting of soil data and failure surface after each analysis
10	Deletes plotting of TEKPLOT after each analysis

The PR command, as used for deleting the critical pool calculations, is illustrated in Figure 10.

```
ENTER COMMAND (LEVEL 1)
*PR

PROGRAM CONTROL

EARTHQUAKE  NUMBER      LIST THE NUMBER OF EACH
G LOAD,  OF SLICES,      DELETE OPTIONS DESIRED
*.05 20 7
```

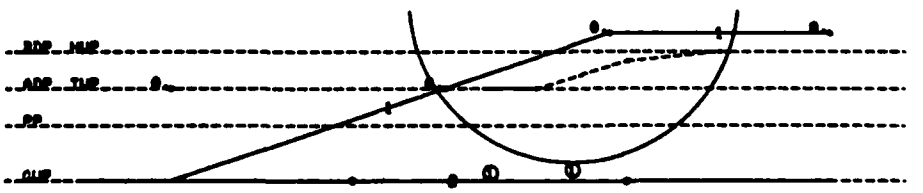


Figure 10. Input using PR command

Table of Soil Properties Command = TA

66. This command provides the user with a current listing of the unit weights, moist and submerged, and the angle of internal friction and cohesion for the Q, R, and S strength tests for each soil. If improper data have been entered, the user may change the material properties with an ED MA command. The use of the TA command is shown in Figure 11.

```
ENTER COMMAND (LEVEL 1)
*TA

SOIL  GAM-M   GAM-S    PHI -   C     PHI -   C     PHI -   C
  1   115.00  125.00    30.     0.    30.     0.    30.     0.
  2   145.00  150.00    45.  1000.    45.  5000.    45.  5000.
                        30.  2000.
                        30.  2500.

ENTER COMMAND (LEVEL 1)
*
```

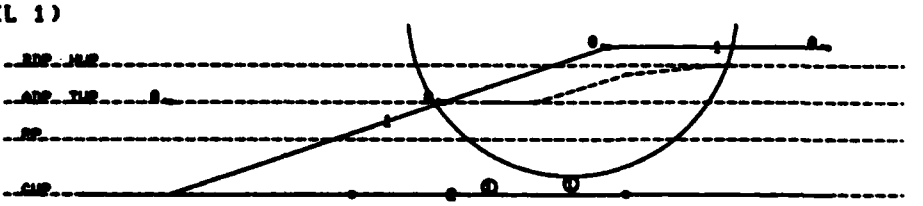


Figure 11. Table of soil properties and display of data

Window Command = WI

67. This command allows the user to pick any rectangular area of the display and magnify it to fill the entire screen. This provides the user with all the details necessary to check the input data. The program responds to the window command by displaying cross hairs, which should be moved to the bottom left-hand corner of the area to be magnified. A character must then be entered, followed by a carriage return. The cross hairs will reappear and should be moved to the upper right-hand corner of the desired area. Another character and a carriage return should be entered. The user can continue giving the WI command to "window" areas of the previous window. To redisplay the entire problem again, the command DI should be entered. Use of the WI command is shown in Figure 12.

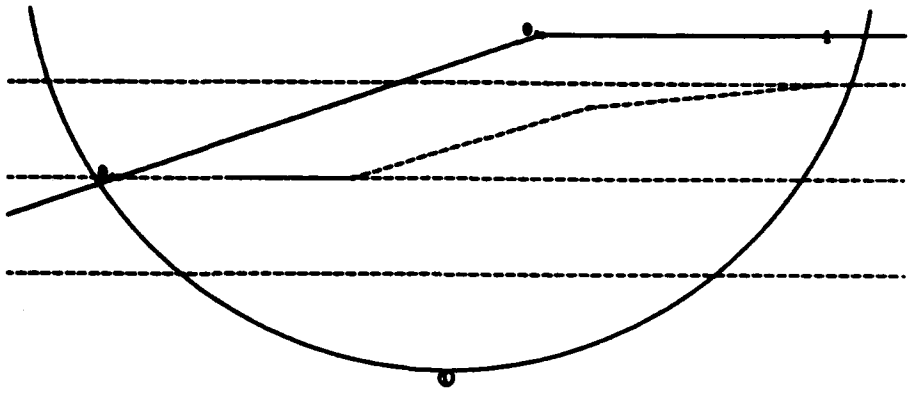


Figure 12. Display resulting from WI command

Display All Data Command = DI

68. The program will respond to this command by erasing the screen and displaying all defined data as shown in Figure 13. The display data will cover as much of the screen as possible, using the same X and Y scale factors.

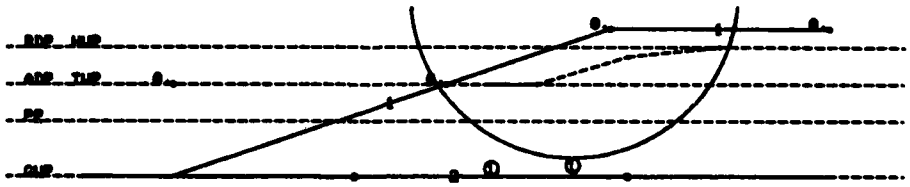


Figure 13. Display resulting from DI command

Restart Command = RE

69. This command will erase all failure surface data. All data associated with the Kansas City commands (paragraphs 51 through 55) will also be erased.

Stop Command = ST

70. If the user desires to exit the program, then the ST command may be entered. If an analysis is not run before this command is entered, the restart file will not be updated.

PART V: EDITING COMMANDS

71. The following commands are used to edit the input data. The soil profile, soil properties, phreatic profile, and piezometric profile may be modified.

Insert New Soil Command = IN

72. This command performs the following functions:

a. Erases all data for soils whose numbers are between N and M.

b. Sets the program to receive a new soil (properites and profile).

c. Inserts the new soil between numbers N and M.

d. Renumbers the soils (starting with 1 for the first soil and continuing in steps of 1 for all soils).

e. Sets the program to add additional soils to the end of the soil list through the SO command (paragraphs 14-23).

73. The program responds to the command IN with:

SOIL INSERTION NUMBERS

SOIL TO FOLLOW WILL BE PLACED BETWEEN SOIL N AND
SOIL M. N MUST BE LESS THAN M. SOILS (N+1)
THROUGH (M-1) ARE ERASED. SUPPLY VALUES FOR N AND M
=

The user supplies values for the soil numbers N and M. The new soil will be placed between soil N and soil M. If M is greater than N+1, soils N+1 through M-1 will be erased and the new soil inserted. If M is greater than the last soil number, then all of the soils from N+1 through the end of the soil list will be erased. If M is less than N, an error note will be printed. Soil N must be present, or an error note will be printed.

74. The program replies with:

SOIL (N+1) PROPERTIES
=

SOIL PROFILE
=

where (N+1) is the number assigned to the soil being inserted. Supply the necessary information as described in SO command, paragraphs 14-23. After an IN command, an SO command may be used to add soils to the end of the existing soil list. For example, if there are 6 soils present and the user desires to

delete soils 4 and 5 and change soil 3, he would use values of 2 and 6, respectively, for N and M. After recording the new profile and properties for soil 3, the program would renumber all soils, and in so doing it would change the number of soil 6 to 4. If the user gives an SO command, the program would store that soil data after soil 4. It would assign the number 5 to that new soil.

Edit Material Properties Command = ED MA

75. The program responds to this command with:

```
SOIL NUMBER TO BE CHANGED
=
```

The user replies with the number of any soil previously defined. An error message will be typed if a soil having this number is not present. After locating this soil, the program types:

```
SOIL i PROPERTIES
SATURATED     Q TEST           R TEST           S TEST
UNIT WT.,     PHI, COHESION,   PHI, COHESION,   PHI, COHESION
-OR-
SAT., WT.  MOIST WT.  Q TEST (1 TO 3)     R TEST           S TEST
                      PHI, COHESION       PHI, COHESION, PHI, COHESION
=
```

where i is the number of the soil requested. The user responds to this request with the new soil properties as described in the section on command SO. All values requested must be input, even though they are the same as the previously stored data.

Edit Soil Profile Command = ED SO

76. The program responds to this command by first displaying the cross hairs. The user must move the cross hairs to the desired soil profile point and enter a character and a carriage return. The program will respond with the following:

```
PRESENT X,Y COORDINATE IS:
13.00     14.00
ENTER NEW COORDINATE
=
```

The program will change all soil profiles which contain the X-Y coordinate picked by the cross hairs to the new coordinate input. The screen will be erased and the new data displayed as shown in Figures 14 and 15.

```
ENTER COMMAND (LEVEL 1)
*ED SO

PRESENT X AND Y COORDINATE IS:
   -10.00     480.00
INPUT NEW COORDINATE
*-10 450
```

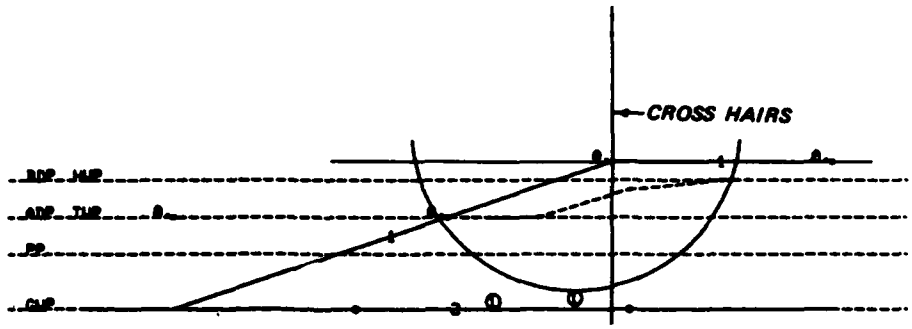


Figure 14. Input using ED SO command - before editing

```
ENTER COMMAND (LEVEL 1)
*
```

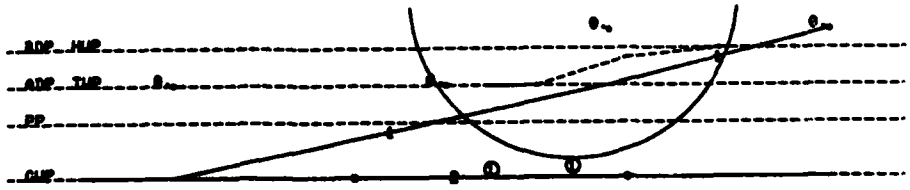


Figure 15. Display resulting from ED SO command - after editing

Edit Phreatic Profile Command = ED PH

77. The program responds to the command ED PH by displaying the cross hairs. The user must move the cross hairs to the desired phreatic profile point and enter a character and a carriage return. The program will respond with the following:

```
PRESENT X AND Y COORDINATE IS:
13.00       14.00
ENTER NEW COORDINATE
-
```

The screen will be erased, and the new data will be displayed as shown in Figures 16 and 17.

```
ENTER COMMAND (LEVEL 1)
*ED PH

PRESENT X AND Y COORDINATE IS:
     0.       465.00
INPUT NEW COORDINATE
*-10 470
```

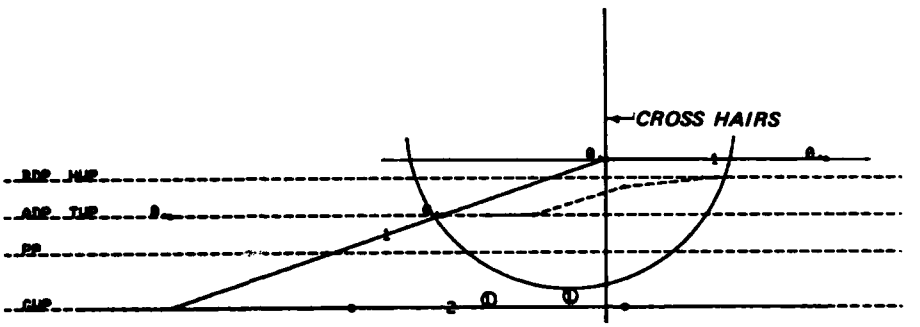


Figure 16. Editing of phreatic profile - before editing

```
ENTER COMMAND (LEVEL 1)
*
```

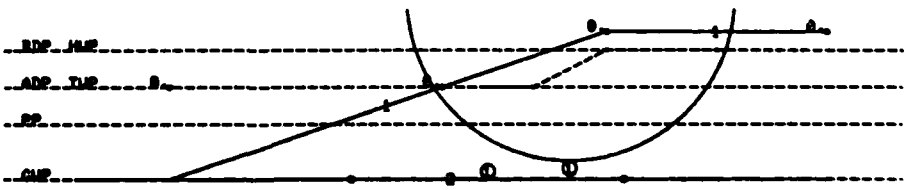


Figure 17. Display of edited phreatic profile - after editing

Edit Piezometric Head Profile Command = ED PI

78. The program responds to this command by displaying the cross hairs. The user must move the cross hairs to the desired piezometric head point and

enter a character and a carriage return. The program will respond with the following:

```
PRESENT X AND Y COORDINATE IS:
13.00    14.00
ENTER NEW COORDINATE AND HEAD
=
```

The screen will be erased, and the new data will be displayed as shown in Figures 18 and 19.

```
ENTER COMMAND (LEVEL 1)
*ED PI

PRESENT X AND Y COORDINATE IS:
   -10.00     480.00
INPUT NEW COORDINATE AND HEAD
*-10 470 0.
```

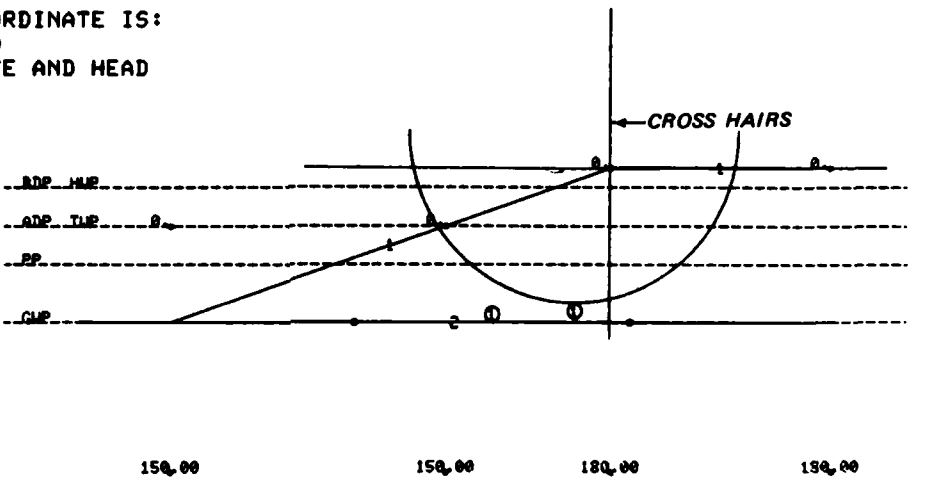


Figure 18. Editing of Piezometric head profile

```
ENTER COMMAND (LEVEL 1)
*
```

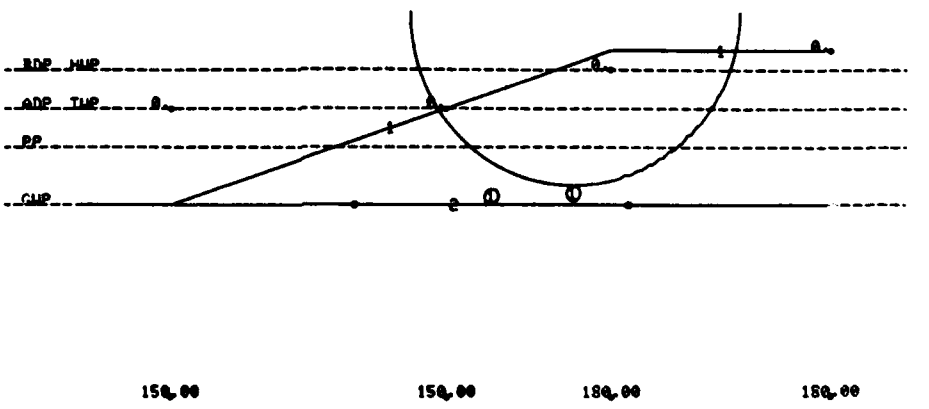


Figure 19. Display of edited piezometric head profile

Delete Neutral Block Command = DE NE

79. When this command is entered, the program will respond with:

ENTER NUMBER OF NEUTRAL BLOCK TO BE DELETED
=

The program will erase the neutral block whose number was entered and renumber the remaining neutral blocks.

Delete Arc Command = DE AR

80. When this command is entered, the program will respond with:

ENTER NUMBER OF ARC TO BE DELETED
=

The program will erase the arc whose number was entered and renumber the remaining arcs.

PART VI: EXECUTION OF DATA

Execute Wedge Analysis Command = RU WE

81. This command causes the page to be erased and the program to calculate the slope stability using the wedge method found in program SSW028 for the problem represented by the current display. It also saves all data input in the restart data file. The following is the output for this analysis:

```
NEUTRAL BLOCK BASE   1
   -150.00,    400.00          0.  ,    400.00

AFTER CONSTRUCTION CASE   USED Q STRGTH BELOW GR WATER     400.000

INITIAL FACTOR OF SAFETY =  2.77

      X       Y    WEIGHT    UPLIFT   SOIL
 -178.64  423.79    59875.       0.     1
 -150.00  400.00   991667.       0.     1
  -10.00  400.00   100000.       0.     1
    0.    400.00   332148.       0.     1
   66.43  420.00        0.       0.     0

     L WEDGE      N BLOCK      R WEDGE       TOTAL
FD   49552.63        0.     -400000.00  -350447.37
FR   22313.54   204095.25    124194.95   350603.73
S.F. = 3.000

DO YOU WANT A TEKPLOT - YES OR NO
=
```

82. The above output shows the output for the stability analysis of neutral block 1. This output includes the following:

a. The coordinates, in feet, of the end points of the neutral block base.

b. The coordinates, in feet, of the end points that define the line segments that make up the failure surface.

c. The weight, in pounds, of the soil above each failure surface segment.

d. The head of water, in feet, that is effective at each end point.

e. The number of the soil through which each failure segment passes.

f. A tabulation of the horizontal components of the driving and resisting forces for the left wedge, neutral block, right wedge, and the total (Note that this tabulation is for the forces that were calculated for the last trial using the developed friction angle).

g. The safety factor for this problem printed as the last line in the output (Note that a negative sign on the safety factor indicates that the direction of failure is from right to left).

The failure surface and water profile are shown in Figure 20.

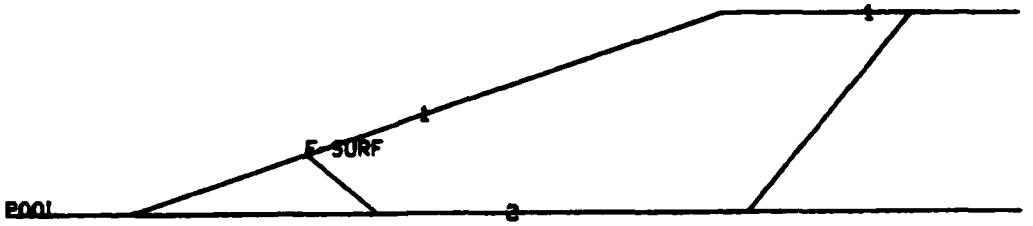


Figure 20. Display of failure surface from wedge analysis

Execute Wedge Analysis With Piezometric Head Command = RU PI

83. This command causes the program to calculate the slope stability using a wedge method with piezometric heads found in program SSW39A for the problem represented by the current display. The data are also saved in the restart data file. The output for the analysis is identical to the SSW028 output except the uplist is described as head (i.e. piezometric head). The following is the output from this analysis:

```
NEUTRAL BLOCK BASE       1
   -150.00,     400.00          0.  ,     400.00

      X        Y      WEIGHT     HEAD   SOIL
  -180.62   423.13   105443.   26.87     1
  -150.00   400.00   286427.   50.00     1
  -100.01   400.00       31.   57.69     1
  -100.00   400.00   731170.   57.69     1
   -10.01   400.00   100080.   80.00     1
      0.    400.00   302152.   72.11     1
    60.43   480.00       0.    0.       0

        L WEDGE      N BLOCK      R WEDGE        TOTAL
FD    102216.25          0.    -400000.00   -297783.75
FR     26578.29    146278.88     125103.76    297960.92

S.F. = 2.032


DO YOU WANT A TEKPLOT - YES OR NO?
*
```

Execute Arc Analysis Command = RU AR

84. This command causes the program to calculate the slope stability using the arc analysis method found in program SSA003 for the problem represented by the current display. Data are also saved in the restart data file.

The output from this analysis contains the coordinates of the failure surface, the head at the ends of each slice, the soil properties used for slice, and the factor of safety for the desired analyses. The following is the output from this analysis command.

```
SLOPE STABILITY , ARC METHOD
BY J CHEEK , WES , JULY 72

A DRUMPLOT CAN BE MADE OF LAST 50 ANALYSES.

ARC  1 OF  1
X =    -30.00  Y =    500.00  R =   90.00

SLICE      X          Y          H       SOIL
   1   -103.9300   448.6870    0.          1
   2    -97.5305   440.5051   10.3180      1
   3    -90.2214   433.1166   20.1429      1
   4    -82.1093   426.6208   29.3436      1
   5    -73.3023   421.1019   37.7973      1
   6    -63.9179   416.6359   45.3915      1
   7    -54.0212   413.2815   52.0247      1
   8    -43.9234   411.0835   57.6087      1
   9    -33.5799   410.0712   62.0688      1
  10    -23.1287   410.2581   65.3456      1
  11    -12.8283   411.6417   67.3955      1
  12     -2.8161   414.2035   68.7965      1
  13      6.8934   417.9094   69.8906      1
  14     16.1113   422.7100   57.2900      1
  15     24.7142   428.5412   51.4588      1
  16     32.5874   435.3253   44.6747      1
  17     39.6261   442.9719   37.0281      1
  18     45.7263   451.3789   28.6211      1
  19     50.8366   460.4342   19.5658      1
  20     54.8589   470.0172    9.9828      1
  21     57.7496   480.0000    0.

SAFETY FACTORS
FOR     G=0     G=0.05      POOL ELEVATIONS
AC     -4.166    -3.040     400.00  USED Q STRGH BELOW GR WATER
SD   -100.254   -73.628     450.00     470.00  SATURATED TO SHELL
PP     -3.703    -2.700     430.00
DO YOU WANT A TEKPLOT - YES OR NO?
*
```

Execute Kansas City Wedge Analysis Command = RU KW

85. This command causes the program to calculate the slope stability using the wedge method contained in the Kansas City wedge program for the problem represented by the current display. The output from this analysis contains the location of trail neutral block, angle of failure surface for both active and passive wedges, total forces from the active, central, and passive blocks, and the factor of safety for each wedge. The data are also saved in the restart file. The following is the output from this analysis:

NO.	POINT A RANGE	POINT A ELEV.	POINT A THETA	POINT B RANGE	POINT B ELEV.	POINT B THETA	FORCES (KIPS) ACTIVE	FORCES (KIPS) CENTRAL	FORCES (KIPS) PASS.	S.F.
1	0.	400.0	50.0	-150.0	400.0	5.0	246.3	202.3	44.6	2.87
2	5.0	400.0	50.0	-150.0	400.0	5.0	249.2	205.5	43.7	2.95
3	-5.0	400.0	50.0	-150.0	400.0	5.0	243.6	198.4	45.5	2.79
4	-10.0	400.0	50.0	-150.0	400.0	5.0	240.8	194.4	46.5	2.71
5	-15.0	400.0	50.0	-150.0	400.0	5.0	237.5	190.1	47.5	2.63
6	-20.0	400.0	50.0	-150.0	400.0	5.0	233.6	185.2	48.4	2.56
7	-25.0	400.0	50.0	-150.0	400.0	5.0	229.1	179.9	49.3	2.50
8	-30.0	400.0	50.0	-150.0	400.0	5.0	224.9	172.8	49.9	2.44
9	-35.0	400.0	50.0	-150.0	400.0	5.0	219.4	166.7	50.8	2.39
10	-40.0	400.0	50.0	-150.0	400.0	5.0	213.4	160.1	51.6	2.34
11	-45.0	400.0	50.0	-150.0	400.0	5.0	207.0	153.2	52.3	2.30
12	-50.0	400.0	45.0	-150.0	400.0	5.0	200.6	146.2	53.0	2.26
13	-55.0	400.0	45.0	-150.0	400.0	5.0	193.9	138.9	53.8	2.22
14	-60.0	400.0	45.0	-150.0	400.0	5.0	186.9	131.4	54.4	2.19
15	-65.0	400.0	45.0	-150.0	400.0	5.0	179.6	123.7	55.0	2.16
16	-70.0	400.0	45.0	-150.0	400.0	5.0	172.0	115.8	55.5	2.14
17	-75.0	400.0	40.0	-150.0	400.0	5.0	164.7	107.9	56.1	2.11
18	-80.0	400.0	40.0	-150.0	400.0	5.0	157.4	100.2	56.6	2.08
19	-85.0	400.0	40.0	-150.0	400.0	5.0	149.9	92.3	57.1	2.06
20	-90.0	400.0	40.0	-150.0	400.0	5.0	142.3	84.4	57.5	2.04
21	-95.0	400.0	40.0	-150.0	400.0	5.0	134.5	76.4	57.8	2.03
22	-100.0	400.0	35.0	-150.0	400.0	5.0	127.4	68.8	58.3	2.01
23	-105.0	400.0	35.0	-150.0	400.0	5.0	120.3	61.3	58.8	1.99
24	-110.0	400.0	35.0	-150.0	400.0	5.0	113.1	53.8	59.1	1.97
25	-115.0	400.0	35.0	-150.0	400.0	5.0	106.4	46.1	59.2	1.96
26	-120.0	400.0	35.0	-150.0	400.0	5.0	98.9	38.9	59.4	1.96
27	-125.0	400.0	30.0	-150.0	400.0	5.0	91.9	32.0	59.9	1.94
28	-130.0	400.0	30.0	-150.0	400.0	5.0	85.6	25.3	60.3	1.93
29	-135.0	400.0	30.0	-150.0	400.0	5.0	79.3	18.7	60.7	1.91
30	-140.0	400.0	30.0	-150.0	400.0	5.0	73.1	12.2	60.9	1.90
31	-145.0	400.0	30.0	-150.0	400.0	5.0	67.2	6.0	60.9	1.90

MINIMUM SAFETY FACTOR = 1.90

Execute Kansas City Arc Analysis Command = RU AR

86. This command causes the program to calculate the slope stability using the Kansas City arc program. The analysis is performed on the problem represented in the current display. The output from the Kansas City arc analysis contains the number of each trail arc, the location of center of arc, radius of arc, driving and resisting forces,and factor of safety for each trail arc. The data are also saved in the restart file. The following is the output from this analysis:

NO.	X	Y	R	DRI	RES	S.F.
1	-30.0	500.0	90.0	186.8	187.0	4.03
2	-25.0	500.0	90.0	192.0	192.1	4.31
3	-35.0	500.0	90.0	181.8	181.6	3.79
4	-40.0	500.0	90.0	176.3	176.2	3.56
5	-45.0	500.0	90.0	170.6	170.6	3.35
6	-50.0	500.0	90.0	164.9	164.9	3.16
7	-55.0	500.0	90.0	159.7	159.6	3.00
8	-60.0	500.0	90.0	154.3	154.2	2.86
9	-65.0	500.0	90.0	148.5	148.5	2.73
10	-70.0	500.0	90.0	142.4	142.5	2.61
11	-75.0	500.0	90.0	136.3	136.4	2.50
12	-80.0	500.0	90.0	130.4	130.5	2.42
13	-85.0	500.0	90.0	124.2	124.2	2.34
14	-90.0	500.0	90.0	117.4	117.4	2.27
15	-95.0	500.0	90.0	110.4	110.4	2.22
16	-100.0	500.0	90.0	102.9	102.9	2.20
17	-105.0	500.0	90.0	95.3	95.3	2.18
18	-110.0	500.0	90.0	88.2	88.2	2.16
19	-115.0	500.0	90.0	81.3	81.3	2.14
20	-120.0	500.0	90.0	74.6	74.6	2.11
21	-125.0	500.0	90.0	68.5	68.5	2.09
22	-130.0	500.0	90.0	62.3	62.3	2.07
23	-135.0	500.0	90.0	56.7	56.6	2.05
24	-140.0	500.0	90.0	50.9	50.9	2.03
25	-145.0	500.0	90.0	45.8	45.8	2.02
26	-150.0	500.0	90.0	40.9	40.9	1.99
27	-155.0	500.0	90.0	36.2	36.3	1.98
28	-160.0	500.0	90.0	31.8	31.8	1.96
29	-165.0	500.0	90.0	27.7	27.7	1.94
30	-170.0	500.0	90.0	23.9	23.9	1.92
31	-175.0	500.0	90.0	20.4	20.4	1.91
32	-180.0	500.0	90.0	17.1	17.1	1.89
33	-185.0	500.0	90.0	14.1	14.1	1.87
34	-190.0	500.0	90.0	11.4	11.4	1.86
35	-195.0	500.0	90.0	9.0	9.0	1.84
36	-200.0	500.0	90.0	6.9	6.9	1.83
37	-205.0	500.0	90.0	5.1	5.1	1.81
38	-210.0	500.0	90.0	3.5	3.5	1.80
39	-215.0	500.0	90.0	2.2	2.2	1.78
40	-220.0	500.0	90.0	1.2	1.2	1.77
41	-225.0	500.0	90.0	0.5	0.5	1.76
42	-230.0	500.0	90.0	0.1	0.1	1.74
43	-235.0	500.0	90.0	NO INTERSECTION		

MINIMUM SAFETY FACTOR = 1.74

PART VII: INPUT DATA FILE FORMAT

87. The format of the data in the input file is, in all respects but one, identical with that supplied by a user who is working with this program in the conversational mode. The exception is that line numbers are required for each line of data. Below is an example of a data file. Old data files which were used for the slope stability programs SSW028, SSW039A, and SSA003 are still valid for DGSLOPE.

```
100 TEST RUN FOR DGSLOPE
110 SO
120 125 115 30 0 30 0 30 0
130 -300 400 -250 400 -10 480 110 480
140 SO
150 150 145 45 1000 30 2000 30 2500 45 5000 45 5000
160 -300 400,
170 110 400
180 NE
190 0 400 -150 400 1 5 5 0
200 PO
210 400 430 470 450 470 450
220 PR
230 .05 20 7
240 AR
250 -30 500 90 1 5 5 5 0
260 PI
270 -250 450 0 -100 450 0 -10 480 0 110 480 0
280 PI
290 -250 300 150 -100 300 150 -10 300 180 110 300 180
```

88. Note that the first line in the file must contain the title. The commands are on a line by themselves. They are followed by the required data on the next line or lines. For instance, line 110 contains the c and SO for soil data input. This is followed, on line 120, by the soil properties and, on line 130, by the soil profile. Although this profile is recorded on one line, it could just as well have been typed on two or more lines as was done for the second soil profile (lines 160 and 170). A comma will allow the user to continue the data on another line.

PART VIII: DRUM PLOTS

89. Creation of drum plots is accomplished by using the "Level 2" commands:

IN - INITIALIZE
ED - EDIT SOIL NUMBERS
DN - DELETE SOIL NUMBERS
AN - RESTORE SOIL NUMBERS
TE - TEKPLOT
EN - ENTER TABLES
DI - DISPLAY TABLES
WI - WINDOW DISPLAY
CH - CHANGE XX
RE - RETURN
ST - STOP
DR - DRUMPLOT

These commands allow the user to select the desired information to be displayed on the drum plots. All drum plots are 42 in. long and 21 in. high.

Initialization Command = IN

90. The initialization phase is an automatic result of entering the drum plot portion of DGSLOPE. However, this phase can be re-entered at any time during the creation of drum plots. The initialization phase allows the selection of up to 10 analyses, as seen below, to be displayed on the drum plot.

```
ENTER UP TO 10 ANALYSES TO BE PLOTTED.
THERE ARE  3 ANALYSES STORED.
ENTER A 0 FOR CURRENT LISTING.
•0
ANALYSIS •  1
AC
FACTOR OF SAFETY •   3.09
ANALYSIS •  2
SD
FACTOR OF SAFETY •   1.92
ANALYSIS •  3
PP
FACTOR OF SAFETY •   2.44
ENTER UP TO 10 ANALYSES TO BE PLOTTED.
THERE ARE  3 ANALYSES STORED.
ENTER A 0 FOR CURRENT LISTING.
•1
```

Editing of Soil Numbers Command = ED

91. Each line segment is numbered with its corresponding soil type. However, even though this is informative, it does not always result in a

desired picture. The ED command allows the user to move or delete the soil numbers to generate a picture desirable to him. This is done by using the cross hairs and three selected characters on the keyboard.

92. When the ED command is entered, the screen is erased, and the soil profiles and soil numbers are displayed. The cross hairs then appear on the screen. The valid characters are:

E - End Editing

M - Move Number

D - Delete Number

A soil number can be deleted by placing the cross hairs over it and entering the character D. A soil number can be moved by placing the cross hairs over it and entering M. The cross hairs then reappear. The user places the cross hairs at the desired location for the soil number and enters any character. This process continues until the character E is entered.

Delete Soil Numbers Command = DN

93. This command is similar to the ED command, except that entering this command will remove all soil numbers from the plot of the data.

Restore Soil Numbers Command = AN

94. This command will restore the soil numbers deleted by the DN command.

TEKPLOT Command = TE

95. The TE command is used to redisplay the drum plot on the graphics terminal screen after editing has taken place. Figure 21 depicts a drum plot on the screen.

ENTER COMMAND (LEVEL TWO)
*

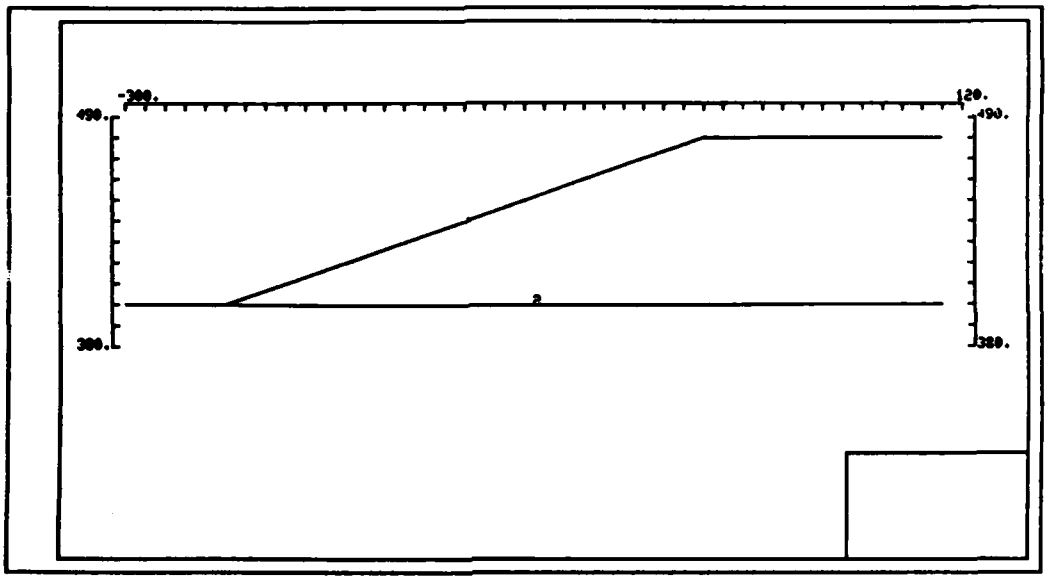


Figure 21. Display of a drum plot on the screen

Enter Table Command = EN

96. The EN command results in a block representing the soil data table and a block for either a wedge data table or an arc data table, depending on the type of analysis at Level 1 (Figure 22).

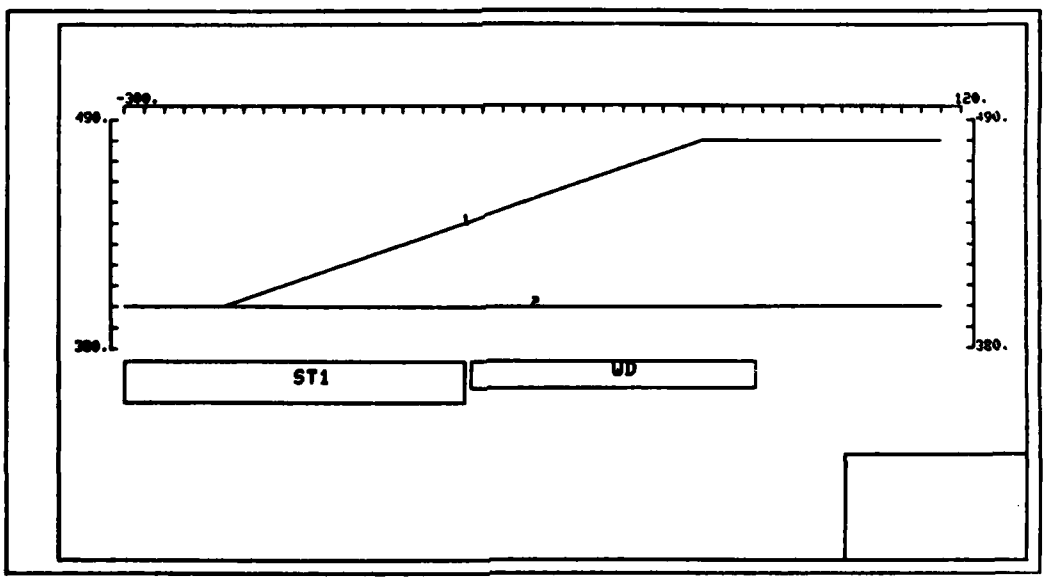


Figure 22. Display resulting from EN command

Display Tables Command = DI

97. The DI command displays, as shown below, the contents of the table entered by the EN (ENTER TABLE) command.

NO.	XA	YA	THETA A	XR	YR	THETA B	ACTIVE	CENTRAL	PASSIVE	SF
1	0.	400.0	50.0	-150.0	400.0	5.0	246.3	202.3	44.6	2.87

SOIL	UNIT WEIGHT		Q TEST		R TEST		S TEST	
	MOIST	SATURATED	PHI	COHESION	PHI	COHESION	PHI	COHESION
1	115.00	125.00	30.00	0.	30.00	0.	30.00	0.
2	145.00	150.00	45.00	1000.00	45.00	5000.00	45.00	5000.00
			30.00	2000.00				
			30.00	2500.00				

WINDOW Command WI = WI

98. This command is used to enlarge a portion of the soil data using the cross hairs and three selected characters on the keyboard. When the WI command is given, the screen is erased and only soil profile data are displayed. The cross hairs then appear. The valid characters are:

W - Window

T - Total Plot

C - Continue

When W is entered, the user must move the cross hairs to the lower lefthand corner, enter any character, move the cross hairs to the upper righthand corner, and then enter any character. The screen is erased, and the data within the window are displayed. An enlarged portion of the soil data resulting from the WI command is shown in Figure 23. Entering character T will result in a display of the entire data. The character C returns the user to the "Level 2" commands.

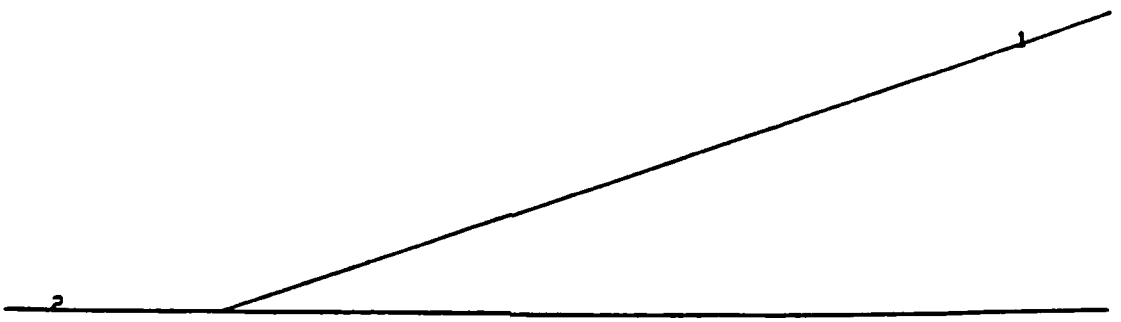


Figure 23. Display resulting from WI command

Change Soil Table Command = CH SO

99. The location of the soil table on the plot can be changed with the CH SO command. The CH SO command results in the display of the cross hairs. The user can then move the cross hairs to locate the new upper left-hand corner of the soil table. The user can enter any character to place the table in the new corner.

Change Wedges Table Command = CH WD

100. The CH WD command changes the location of the wedge data table on the plot. Entering this command results in a display of the cross hairs. The user can then move the cross hairs to locate the new upper left-hand corner of the wedge data table. The user can enter any character to place the table in the new corner.

Change Arc Table Command = CH AR

101. The CH AR command is similar to the CH SO and CH WD commands, except that it applies to the arc data table.

Change Tic Interval Command = CH TI

102. This command results in the following:

"Enter New Distance Between Tic Marks"

=

This allows the user to control the placement of the tic marks on the drum plot.

Return Command = RE

103. The command RE returns the user to the "Level 1" commands.

Stop Command = ST

104. The ST command allows the user to exit the program.

Drum Plot Command = DR

105. The DR command results in a series of questions that must be answered in order to generate a drum plot. An example using the DR command and the resulting series of questions is shown below.

```
ENTER COMMAND (LEVEL TWO)
*DR
ENTER IDENT CARD INFORMATION
FOR WES: USERID,NAME
FOR MACOM: ACCOUNT NUMBER,NAME,USERID
*1000RO,MP,11R0KASLP
INPUT STATION CODE FOR OUTPUT (00 IF NOT REMOTE)
*R0
ARE CALCOMP ROUTINES ON SYSTEM LIBRARY (YES OR NO)?
FOR WES: YES
FOR MACOM: NO
*NO
ENTER LIBRARY WHERE CALCOMP ROUTINES ARE STORED
FOR MACOM: 11R0KPLIB/WESTARL
*11R0KPLIB/WESTARL
ENTER LOCATION TO WHICH YOUR PLOT SHOULD BE SENT
*ADP,WES
INPUT PRIORITY (5 OR 40)
*5
$NUMB-1928G
```

Recommended Use Of Program

106. An engineer will get results from this program much more efficiently by using an input data file. The interactive commands can then be used to edit or change existing data and control the analysis process. The use of the interactive commands for building a new data file can be very time consuming on many of the computers presently serving the Corps.

107. The user should never be concerned with drum plot commands until the final results have been determined. The final failure surface, i.e., minimum factor of safety, is plotted with failure surfaces which have higher factors of safety and indicate that the failure surface with minimum factor of safety has been determined. This is not a final plot for a design memorandum plate but can be developed into a final plate with little additional drafting.

APPENDIX A: SUMMARY OF COMMANDS FOR LEVEL 1

Functional Area	Command	Description	Used By Program: Kansas City Programs	Used By Program: LMVD Programs
Soil Data	SO	Defines Soil Strengths and Profiles	Yes	Yes
Failure Surface Data				
	NE	Defines Neutral Block For Wedge Analysis	Yes (Active Wedge Passive Wedge)	Yes (End Points for Neutral Block)
	AR	Defines Arc Failure Surface	Yes (One Stunting Arc)	Yes (Several Different Arcs)
	GE	Generates Arc	No	Yes
Water Surface Data				
	PO	Input Pool Elevation Data	No	Yes
	PI	Define A Piezometric Head Profile	No	Yes
	PH	Define Phreatic Profile	Yes	Yes
	GA	Define Unit Weight of Water (Defaults 62.5 pcf)	Yes	Yes
Special Kansas City Commands				
	SL	Define Scope of Active Earth Force	Yes	No
	SS	Define the Desired Soil Strength	Yes	No
	PE	Define Percent Consolidation (only used with Q strengths)	Yes	No
Program Control Commands				
	CO	For Conversational Output		
	NO	Delete Conversational Output		
	RE	Read Old Data File for Input Data		
	PR	Program Control for LMVD Programs		
	TA	List Table of Soil Properties		
	WI	Define Window of Display with Cross Hairs		
	DI	Display Entire Profile Data		
	RS	Restart - (Delete All Data)		
	S7	Stop Execution of Program		
Editing Commands				
	ED MA	Edit Material Properties		
	ED SO	Edit Soil Profiles		
	ED PH	Edit Phreatic Profile		
	ED PI	Edit Piezometric Profile		
	DE NE	Delete Neutral Block		
	DE AR	Delete Arc		
Execute Stability Analysis				
	RU KW	Executes Kansas City Wedge Analysis		
	RU KA	Executes Kansas City Arc Analysis		
	RU WE	Executes LMVD Wedge Using Pool Elevations and Phreatic Profile Data (SSW028)		
	RU PI	Executes LMVD Wedge Using Piezometric Head Profiles (SSW39A)		
	Ru AR	Executes LMVD Arc (SSA003)		